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(54) Ablation catheter and method for isolating a pulmonary vein

(57) A catheter assembly for treatment of cardiac arrhythmia, for example, atrial fibrillation, by electrically isolating a vessel, such as a pulmonary vein, from a chamber, such as the left atrium. The catheter assembly includes a catheter body 22 and at least one electrode 26. The catheter body includes a proximal portion 28, an intermediate portion 30 and a distal portion 32. The intermediate portion extends from the proximal portion and defines a longitudinal axis. The distal portion extends from the intermediate portion and forms a sub-

stantially closed loop 34, parallel or transverse to the longitudinal axis. The at least one electrode 26 is disposed along the loop. With this configuration, the loop is axially directed into contact with the chamber wall about the vessel ostium. Upon energization, the electrode ablates a continuous lesion pattern about the vessel ostium, thereby electrically isolating the vessel from the chamber.

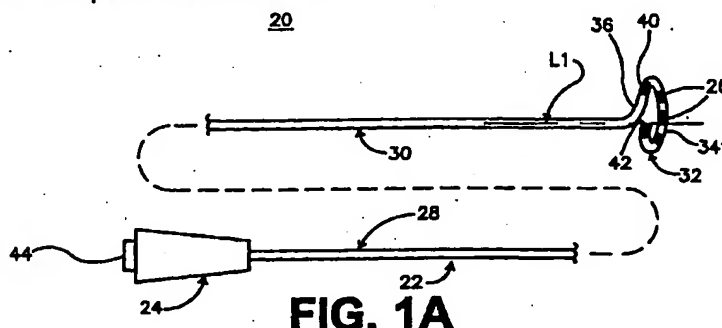


FIG. 1A

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are cooled, such as by forcing a cooling liquid through the wire struts 350. The balloon 340 is deflated and the wire basket 334 maneuvered to the contracted position (FIG. 12A). The entire catheter assembly 330 may then be removed from the patient. Alternatively, the catheter body 332 may be retracted from the patient along the guide wire 338 and replaced with a separate catheter device (not shown). To this end, the catheter body 332 may be configured to provide a rapid exchange feature, as would be apparent to one of ordinary skill.

[0083] The pulmonary vein isolation catheter of the present invention, and in particular the substantially closed loop configuration, provides a highly viable tool for electrically isolating a vessel, such as a pulmonary vein, from a chamber, such as the left atrium. In this regard, the substantially closed loop is orientated transverse to a longitudinal axis of the catheter assembly so as to facilitate rapid, consistent placement of the ablation loop at a desired location along the left atrium or other chamber wall. This transverse orientation allows for guiding of the catheter assembly in a direction parallel to the axis defined by the vessel ostium, as opposed to a radial approach. Thus, the numerous complications presented by prior art sliding techniques are avoided. Further, due to this transverse orientation, the catheter assembly can further be provided with a locating device extending distal the ablation loop for easily locating a particular vessel, as well as to center the loop around the vessel ostium. Finally, the locating device can be provided with mapping electrodes such that mapping of the pulmonary vein in conjunction with ablation about the pulmonary vein ostium can be achieved with a unitary device.

[0084] Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. For example, the preferred embodiment has described electrical isolation of a pulmonary vein from the left atrium for treatment of atrial fibrillation. Alternatively, the method and apparatus of the present invention may be utilized in the treatment of other cardiac arrhythmias, such as isolating the coronary sinus from the left atrium or isolating the outflow tract (or pulmonary valve) from the right ventricle. Further, a number of the described embodiments have included a catheter body forming a single loop. Alternatively, a multi-plane coil or spiral may be formed. The coil or spiral may increase or decrease in diameter as it extends distally, or may have a uniform diameter. Additionally, while the loop has been described as preferably being circular, a variety of other substantially closed shapes, including square, triangular, octagonal, etc. are equally acceptable. Also, several of the described embodiments have included a locating device for centering the loop about a pulmonary vein ostium and for mapping a pulmonary vein. In this regard, the locating device may be configured to serve only as a center-

ing device or only as a mapping device, or both. Finally, other features may be incorporated into the catheter assembly. For example, to expedite deployment, the catheter assembly may be configured to slidably receive a guide wire used to position the catheter assembly within the left atrium. Even further, the catheter assembly may include a rapid exchange feature for quick placement over and removal from the guide wire.

10 Claims

1. A catheter assembly for treatment of cardiac arrhythmia comprising:

a catheter body (22) including:

a proximal portion (28), an intermediate portion (30) extending from the proximal portion and defining a longitudinal axis, a distal portion (32) extending from the intermediate portion and forming a substantially closed loop (34); and at least one electrode (26) disposed along the distal portion; characterised in that

upon activation, the at least one electrode ablates a continuous, closed lesion pattern in a plane substantially perpendicular to the longitudinal axis for isolating material within the closed lesion pattern.

2. The catheter assembly of claim 1, wherein the loop (34) is substantially circular.
3. The catheter assembly of claim 1 or 2, wherein the loop (34) is sized such that the continuous lesion pattern has a diameter greater than a diameter of a pulmonary vein ostium formed in a left atrium.
4. The catheter assembly of any preceding claim, wherein the distal portion (32) includes a loop segment (72A-C) of at least one revolution for forming the loop.
5. The catheter assembly of claim 4, wherein the distal portion further includes a lateral segment extending laterally from the intermediate portion, the loop section extending from the lateral section.
6. The catheter assembly of claim 4, wherein the loop segment revolves about a central loop axis (C2) substantially parallel with the longitudinal axis.
7. The catheter assembly of claim 4, wherein the loop segment includes a proximal section and a distal section, and further wherein the proximal section is sufficiently flexible such that upon contact between the distal section and a tissue wall, the proximal

section deflects toward the distal section with further distal movement of the catheter body.

8. The catheter assembly of claim 1, wherein the distal portion forms a plurality of loops combining to form a cylinder. 5
9. The catheter assembly of claim 1, wherein the distal portion forms a plurality of loops combining to form a cone. 10
10. The catheter assembly of claim 9, wherein the plurality of loops includes a first loop segment having a diameter greater than a diameter of a pulmonary vein ostium formed in a left atrium. 15
11. The catheter assembly of claim 10, wherein the plurality of loops includes a second loop segment having a diameter less than a diameter of a pulmonary vein ostium formed in a left atrium. 20
12. The catheter assembly of any preceding claim, further comprising:
 - a locating device (86) for centering the loop about an ostium. 25
13. The catheter assembly of claim 12, wherein the locating device (86) includes a tip (100) extending distal the loop, the tip being sized for placement within a vessel. 30
14. The catheter assembly of claim 13, wherein the tip (100) forms a coil, at least a portion of the coil defining a diameter approximating a diameter of a pulmonary vein. 35
15. The catheter assembly of claim 13 or 14, wherein the locating device (138) further includes an balloon (136) positioned distal the loop. 40
16. The catheter assembly of claim 13 or 14, wherein the locating device (168) further includes an expandable wire basket (166) positioned distal the loop. 45
17. The catheter assembly of any of claims 12 to 16, wherein the locating device is integrally formed with the catheter body. 50
18. The catheter assembly of claim 12, wherein the locating device (196) includes an elongated shaft proximal the tip, the catheter assembly further comprising: 55

means (198) for slidably maintaining the elongated shaft relative to the catheter body.

19. The catheter assembly of claim 18, wherein the means for slidably maintaining the shaft is a sheath (198) coaxially receiving the shaft and the catheter body.

20. The catheter assembly of any preceding claim, further comprising:

- a mapping device (102) for mapping tissue distal the loop.

21. The catheter assembly of claim 20, wherein the mapping device includes a probe tip maintaining at least one mapping electrode, the probe tip extending distal the loop.

22. The catheter assembly of claim 21, wherein the probe tip has a diameter less than a diameter of a pulmonary vein.

23. The catheter assembly of claim 21, wherein the probe tip forms a conical coil.

24. The catheter assembly of any of claim 20 to 23, wherein the mapping device is integrally formed with the catheter body.

25. The catheter assembly of claim 19, wherein the mapping device includes an elongated shaft having a probe tip at a distal end thereof, the catheter assembly further comprising:

- means for slidably maintaining the elongated shaft relative to the catheter body.

26. The catheter assembly of claim 25, wherein the means for slidably maintaining the shaft is a sheath coaxially receiving the shaft and the catheter body.

27. The catheter assembly of any preceding claim, wherein the intermediate portion includes a proximal section and a distal section adjacent the distal portion, the distal section configured to be more flexible than the proximal section for allowing deflection of the distal portion relative to the proximal section.

28. The catheter assembly of any preceding claim, further comprising:

- an elongated guide body having a central lumen and defining a proximal end and a distal end, the catheter body being slidably maintained within the central lumen such that in a deployed position, the distal portion of the catheter body extends distally from the distal end of the guide body, and in a retracted position, the distal portion is proximal the distal end;

wherein the distal portion is substantially straight in the retracted position.

29. The catheter assembly of any preceding claim, wherein the distal portion is made of a shape memory material such that the distal portion forms the loop in the deployed position. 5
30. The catheter assembly of any preceding claim, wherein the catheter body includes a central lumen extending from the proximal portion to the distal portion, the catheter assembly further comprising: a stylet slidably maintained within the central lumen for selectively rendering the distal portion substantially straight. 10 15
31. The catheter assembly of any preceding claim, wherein the distal portion includes a basket maintaining a plurality of electrodes, the basket being selectively expandable to position the electrodes in a loop configuration transverse to the longitudinal axis. 20
32. The catheter assembly of any preceding claim, wherein the substantially closed loop is transverse to the longitudinal axis. 25
33. The catheter assembly of any of claims 1 to 31, wherein the loop defines a central loop axis substantially parallel to the longitudinal axis. 30
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